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THE *Coefficient* OF LIPSTICK DISTRIBUTION

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Ordinarily *The Ohio State Engineer* publishes only articles which have been prepared by its own staff. An exception is being made in this case because of the importance of this article during the present emergency as part of the program for conservation of strategic materials. The article first appeared in the spring issue of *The Cincinnati Cooperative Engineer* and is reprinted here by permission.—EDITOR.

WHEN two surfaces, one of which is coated with a layer of lipstick, meet, a certain distribution of the lipstick takes place. The second surface which was originally clean retains a portion of the material. This paper is a study of the variables affecting this distribution and the determination of the coefficient of distribution.

NOMENCLATURE

P—pressure
T—number of applications
C—temperature
A_1—area of the transmitter
A_2—area of receiver
i—intensity of light
N—Newton's constant
p—pucker factor
t—time
Π—passion
B—surface conditions
Δ—distribution coefficient
D—distribution

NOTES ON THE VARIABLES

The most important variable in the distribution of lipstick is that of pressure. Harris reports that in 193 tests, using variations in pressure, the amount of material transferred was a direct function of the pressure. This report tends to bear out the experiments of Stockfleth, who used several transmitters under the same laboratory conditions, i.e., on the same night. Stockfleth conducted his tests in the Theta Phi Alpha laboratory in 1941. When the pressure is zero, the distribution is also zero; as pressure increases, the flow of lipstick increases rapidly up to a certain maximum. Under extremely high pressures, the equilibrium conditions are reached almost immediately. Equilibrium occurs when the amount of lipstick on one surface is equal to that on the other.

It has been found that if pressure is plotted against distribution, the curve assumes the shape of a "puckered pair" of lips. (This is standard nomenclature for this phenomenon. To say a "pair of puckered lips" infers that one lip can be puckered independently—an impossibility.) The exact shape of the curve is determined by p, the pucker factor (see Figure 1).

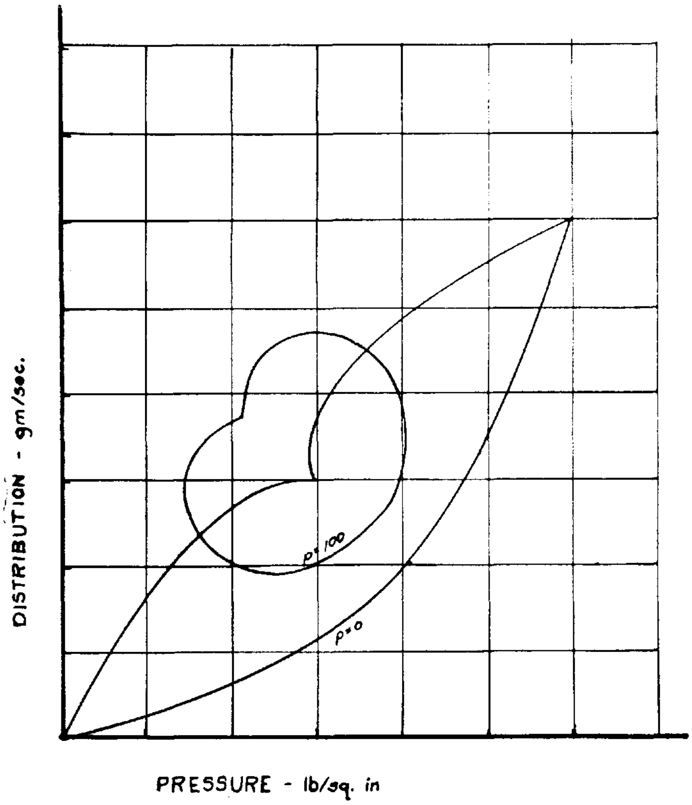

FIGURE 1

B, the variable measuring the surface conditions, is an exponential function of the pucker factor and pressure. Under normal operating conditions, the surface of the contacting areas is fairly smooth. However, if the surfaces are contracted and drawn up into folds and wrinkles, i.e., puckered, surface conditions are far from being ideal for complete distribution. As pressure increases the surface becomes more ideal, i.e., smooth.

Other factors are also important in the distribution ratio. The intensity of light, i, has an

Fig. 2. Laboratory Under Lighting Conditions Permitting Infinite Distribution

inverse effect. As light becomes brighter, less and less lipstick is distributed. The amount dispensed in total darkness approaches infinity (see Figure 2).

An unusual effect of Newton's gravitational constant is noted in the following relationship. If there are only two surfaces within range, the distribution is normal. If, however, a third surface is near, the distribution falls off to almost nothing. Yet, with the addition of a fourth sur-

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face of opposite gender to the third, the rate of flow is twice as great as before.

Teppig attempted a series of experiments to determine the effects of passion, but failed at first because of transmitter trouble. In another attempt the defense failed, and accurate results were obtained. The cause of *II* passion, is as yet unknown, but it has been shown that any amount of it renders useless the consideration of any other variable. *II* causes the number of applications per unit time to increase greatly. The study of this variable is the most difficult of all, but Teppig's work seems quite adequate.

Other variables of less importance include temperature, area of the transmitter, and area of the receiving surface. It seems that more lipstick is distributed in the month of June, a period of high temperature, than in any other month of the year. The areas of the contacting surfaces have their direct effect.

WORKING EQUATIONS

(1) $\Delta = \frac{(T+i)\ C_m\ NA_1}{Ti\ (B)\ P\ A_2}$

(2) $D = \Delta PII$

UNITS

P=pressure in lb./sq. in.
T=number of applications
C=mean centigrade temperature of the mouth
A_1=area of transmitter in sq. in.
A_2=area of receiver in sq. in.
t=time in seconds
i=light intensity in candlepower
B=Standard Rasp Number (A.S.M.)
p=pucker factor in wrinkles/linear inch

METHODS OF CONDUCTING TESTS

To secure the necessary data for use in the equations, tests must be conducted under standard conditions. One variable alone is allowed to vary in each set of determinations. The only apparatus necessary is the lipstick, two willing surfaces, and a standard 200-mesh linen handkerchief which must be unstarched. A test of pressure, for example, will probably require twenty determinations all with different pressures. The results should be placed in order around the edge of the handkerchief with notes as to the surface conditions. If any signs of passion are present, disregard the results of the tests, but continue to run them until all signs of passion are dissipated. As many as 150-175 determinations may be run in the course of an evening under normal operating conditions. If conditions become ideal, do not hesitate to take advantage as they may be hard to duplicate.